EPM5700 Project Management and Information Technology

COST MANAGEMENT AND EARNED VALUE FOR IT PROJECTS

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About this course

Intellectual property

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COST MANAGEMENT TECHNIQUES FOR IT PROJECTS

IT project costs are well known for going over budget, this is mainly because of development approaches that allow scope creep during the product development life cycle. Research shows that there is also a tendency for IT cost estimates to be less fixed than those of hard projects in fields such as construction and engineering, where maturity in planning and estimating is higher. In her book *Information Technology Project Management*, Kathy Schwalbe suggests that the people creating cost estimates for IT projects lack experience compared to specialist cost surveyors who create cost estimates for construction projects.

Additionally, given how multifaceted these projects tend to be and how quickly IT evolves, IT projects often suffer from the "first-time, first-use penalty," which means that it is hard to form accurate estimates when a project or project techniques such as agile or waterfall have not been attempted before. It makes a great deal of sense to perform a lessons learned analysis and document those lessons in IT projects.

Gartner a U.S. research and advisory firm specialising in the IT industry creates a research report for the project and portfolio management market that categorizes vendors into four categories based on their ability to understand market needs and to drive the acceptance of new technologies. These are graphed on axes labelled "completeness of vision" and "ability to execute," respectively.

Cost management is concerned with the process of planning and controlling the budget of a project or business. It includes activities such as planning, estimating, budgeting, financing, funding, managing, and controlling costs so that the project can be completed within the approved budget. Cost management covers the full life cycle of a project from the initial planning phase towards measuring the actual cost performance and project completion. This presentation will explain the different steps or processes in Project Cost Management, in line with methods such as the PMBOK.as Excel spreadsheets seem to be the norm.

As has previously mentioned ICT projects over the years have earned a reputation for not completing on budget and time. The use of Cost management is not generally implemented. However, there are four major phases ICT Project Managers should consider for Cost Management as per the PMBOK

COST MANAGEMENT: FOUR MAJOR STEPS

The Project Management Body of Knowledge (PMBOK), the bible of project management theory, says cost management is made up of four processes. These generally adhere to the sequence that follows — as a project goes from the planning board to reality.

Source: PMBOK

FIRST PHASE: RESOURCE PLANNING

- In the first phase of a project the required resources need to be defined to complete the project activities. Work Breakdown Structures (WBS) and historical information of comparable projects will be used to define which physical resources are needed. The Stakeholders can be of assistance as to the required time, and required resources such as material, labour, equipment, etc. Once the resource types and quantities are known the accompanying costs can be determined.

SECOND PHASE: COST ESTIMATING

- There are many cost estimating methods which could be applied to predict how much it will cost to perform the project activities. The choice for the estimation method depends on the level of information available. Analogous estimating using the actual cost of previous, similar projects can serve as a basis for estimating the current project. Another option is to use parametric models in which the project characteristics are mathematically represented. Estimates can be refined when more information becomes available during a project. Eventually this results in a detailed unit cost estimate with a high accuracy. Remaining uncertainties in estimates that will likely result in additional cost can be covered by reserving cost (e.g. using escalation and contingencies).

THIRD PHASE: COST BUDGETING

- The cost estimate forms with a project schedule together the input for cost budgeting. The budget gives an overview of the periodic and total costs of the project. The cost estimates define the cost of each work package or activity, whereas the budget allocates the costs over the time when the cost will be incurred. A cost baseline is an approved time-phased budget that is used as a starting point to measure actual performance progress.

FOURTH PHASE: COST CONTROL

- Cost control is concerned with measuring variances from the cost baseline and taking effective corrective action to achieve minimum costs. Procedures are applied to monitor expenditures and performance against the progress of a project. All changes to the cost baseline need to be recorded and the expected final total costs are continuously forecasted. When actual cost information becomes available an important part of cost

control is to explain what is causing the variance from the cost baseline. The results of this analysis are that corrective action might be required to avoid cost overruns.

Cost control software tools dedicated to the process can be valuable to define cost control procedures, track and approve changes and apply analysis. In addition, reporting will be improved and abridged which makes it easier to inform all stakeholders involved in the project.

Major COMPONENTS OF THE COST MANAGEMENT PLAN

A cost management plan is developed to manage these four processes. It is created during the project planning phase, the cost management plan is a document that defines how the project is to be managed, controlled, and to communicate the project's costs such that it will completed on budget.

In addition the cost management plan identifies the person or group responsible for cost management, specifics how a project's cost performance will be assessed, and establishes rules for the communication of cost performance to project stakeholders. It will also establish the processes by which project cost variations will be controlled

The cost management plan should be tailored to fit the organization's needs, it will generally follow a standard format. Chapters may include the cost variance plan, the cost management approach, information on cost estimation, the cost baseline, cost control, and reporting processes, the change control process, the project budget, and approvals. There may also be a need to include the spending delegations for key project personnel, indicating which roles can approve costs up to specific limits.

- **Cost Variance Plan:** Cost variance is when the actual amount differs from the budgeted amount. In the project's cost management plan, it will need a chapter that details the actions that should be taken, including those held responsible in the case of a cost variance. The extent of the variance usually necessitates various action: a cost variance of less than say five percent might result in an explanation of that variance, while a 95-percent-or-greater variance might be likely to force the project to be abandoned.
- **Cost Management Approach:** This chapter outlines the approach the project manager will use for cost management. The integrity level can vary, but it describes how to establish the cost baseline and how to compare actual costs. Control accounts are used to track and report costs through the project, including the roll up costs of subtasks. This should occur at the level three of the work breakdown structure. However, the level at which the project manager wishes to track, and report depends on the scope of the project.
- **Cost Estimation:** This is where the definition of the methods used for estimating project costs, the levels of variation, and the expected precision, accuracy, and risk occur
- **Cost Baseline:** Has a specific meaning in project management and represents the authorized, time-phased spending plan against which cost performance is measured. It's the sum of the estimated project cost and contingency reserves.
- **Cost Control and Reporting Process:** This chapter establishes how costs are measured and their key metrics during the project.
- **Change Control Process:** This chapter describes the processes for making changes to the cost baseline and how to approve those proposed changes by the delegated authority
- **Project Budget:** The budget is built on the cost baseline by totalling the cost of running the project (including contingencies for possible risks). It adds in management reserves, the amount to account for unanticipated risks or unidentified events that may arise. The organization will have to establish a policy for this, and the amount is generally between five to 15 percent of the total budget.

COST MANAGEMENT ACTIVITIES: ESSENTIAL FUNCTIONS AT EACH PHASE

Cost management includes several activities conducted at different phases during the project life cycle. It's important to include the cost management function while developing project plans so that solid financial controls are built into the project structure. The following are some key terms and stages relevant to cost management:

Planning: Using the work breakdown structure to determine the resources needed to complete a job or project.

Estimating: The act of calculating or predicting the expected total cost of completing a project.

Budgeting: The authorization of a budget based on a cost estimate to complete the project. Typically authorize budgets in tandem with schedules, so that cost performance can be assess at specific points in time

Financing and Funding: The process of requesting, authorizing, and receiving money for a project.

Cost Management: The general practice of overseeing project expenditures and making cost-related decisions throughout the project life cycle.

Controlling: Addressing cost variations to avoid cost overruns.

Job Control: Controlling project expenditure by comparing costs predicted by the cost estimate and costs actually being incurred.

Scheduling: Determining a project's cost performance by using the schedule that compares the expected expenditure to the actual costs the project is incurring at any point in time.

Accounting: The practice of recording expenditures and reconciling transactions.

HOW ACCURATE PROJECT COST ESTIMATING AIDS COST MANAGEMENT EFFORTS

The first step towards vigorous cost management is having a clear idea of the project's likely costs. However, it's futile to track and control costs if spending is based on unrealistic estimates.

Project estimating considers several variables, including the method used to develop the estimate, the stage at which the estimate is built, and the types of costs which have been included.

The first variable is the method used. Cost estimates can be produced by a variety of estimating techniques, depending on the extent to which the project has been defined and the type of information available. Some common estimation techniques:

- **Analogous Estimating:** Uses historical data from similar past projects to create estimates for new projects. This method works if experience with projects of the same type exists
- **Parametric Estimating:** This method estimates time and cost by multiplying per unit or per task amounts by the total number expected in the project. The rates are often standard or publicly published rates (for example Slattery's) and can be expressed in hours of work, amount of data

entered, or the number of units of a product manufactured. See the table below for Slattery's Classification of estimates

This technique has a reputation for good reliability, but it's less relevant when output isn't uniform, such as when writing computer code. Some projects have widely varying or unprecedented tasks, so they do not lend themselves to this method.

Estimate type	Applicability	Order of Accuracy
Order of magnitude	When the project is first mooted, to establish its broad viability or a first budget for fiscal planning	+/- 30%
Preliminary	When some information on the project has been developed, to determine more accurately the magnitude of the financial commitment or to evaluate alternatives	+/- 20%
Definite	Prepared during the detailed design phase to ensure that the cost of the structure or facility developing from the design process is within budget, or the probable extent of the overrun	+/- 10%
Detailed	Prepared by a contractor as part of the process of preparing a tender for the construction of a project	+/- 5%

Slattery's Classification of Estimates

- **Bottom-Up Estimating:** This is a determinative estimating technique that estimates costs for work breakdown structure components and adds them together to create a cost estimate for an entire project. The project team members aid in the development of the estimate. Since the project team members who are going to be doing the work are engaged in estimating, professionals consider this method highly accurate, as well as a team commitment builder.
- **Three-Point Estimating:** This is a PERT-related statistical method that uses the optimistic (lowest), pessimistic (highest), and most likely cost estimates to create expected values and standard deviations for project expenditures.
- **Software-Based Estimating:** You can use software-based estimating techniques, such as Monte Carlo simulation, to model the effects of risk events on project costs. There is Function Point Analysis which is considered very important in estimation of a software project

Another factor influencing the cost estimating is the stage in the development of the project data at which the cost estimate is built. As a project progresses, more variables and actual costs become apparent, so project estimates become more refined. Can classify cost estimates based on how well the project scope was defined at the time of estimation and on the type of estimation technique applied; the latter will determine the accuracy of an estimate. In order of accuracy, the main classes of cost estimates are:

- **Order of Magnitude Estimates:** These are very basic cost estimates based on expert judgment and on adjusting the costs of the current project to reflect the costs of similar, previous projects. Having been created before a proper and full definition of the project, they are only used in high-level project forecasts. (Colloquially known as "Ball

Park"). It should be noted that when such high level costs become common knowledge, they will set an expectation that these costs are the "real costs", which then leads to un-informed comments, such as the project is over budget, so great care must be taken when promulgating them.

Preliminary Estimates: A preliminary estimate uses a more detailed scope information to form estimates based on unit costs. These estimates are accurate enough to use as the basis for budgeting.

Definitive Estimates: Created when the project's scope is fully defined a, a definitive estimate uses deterministic estimating techniques, such as bottom-up estimating. Professionals agree that definitive estimates are the most accurate and reliable.

The last variable which can affect project estimates are the type of costs included. the project budget must include all the relevant costs for labour and materials, but whether there is a need to include a portion of the organization's indirect costs depends on the organization's policies and the type of project. Below are the terms normally used to determine between various types of costs:

Direct Costs: Direct costs are those which can be directly associate with a specific cost object. They are billable to specific projects.
Indirect Costs: Indirect costs cannot be associated with a specific cost object and may typically incur indirect costs by several projects at the same time. They are not invoiceable to specific projects.
Fixed Costs: Fixed costs are costs which are incurred during manufacturing but are not associated with the volume of produced output.
Variable Costs: Variable costs are costs which are incurred during manufacturing that are directly associated with the volume of produced output.
Sunk Cost: A sunk cost is an expense that cannot recoup once it is incurred.
Opportunity Cost: When selecting a course of action, its opportunity cost is the loss of potential benefits from all alternative courses of action.

COSTING TECHNIQUES DETERMINE HOW TO ACCOUNT FOR PROJECT COSTS

A costing technique is the way in which the total cost can be calculated to produce a product or performing a task. Depending on the activity or activities being costed, a variety of techniques be may use. Below are some commons ones:

Job Costing: Managers use job costing, to determine the cost of a product that is unique or dissimilar to other products. In construction and similar industries, it's not likely for two jobs to be identical. Job-order costing uses a unique job-cost record that compiles total labour and resource costs, as well as associated overheads, for every task or activity completed as part of a job to determine total expenditures for the job. The job-cost record includes both direct and indirect costs.

Process Costing: Process costing can be used to determine costs for products or tasks that are identical. Contrasting with job costing, it does not calculate the total cost of a product by accumulating the costs of all tasks and activities that go into creating the product. Instead, process costing expresses the processes included in the mass production that manufacture products. Through dividing the total cost of a process by the number of units output, it is then possible to determine the cost per unit of each process. Having done this then, may total the costs per unit of every process involved during manufacturing of the product. Thus, can compute the cost per unit of each product on a process-by-process basis.

Activity-Based Costing: Activity-based costing (ABC) is a method for assigning overhead costs to products. Since overhead cost allocation based merely on the required number of machine hours could be misleading, this costing technique looks at the activities focused on manufacturing a product — testing, creation of specialised software, machine setup and then assigns parts of their costs to all products created using these activities. Products that were not created through these activities will not have a share of these activities' costs added on.

Direct Costing: A method in which the cost of a product or operation is determined by allocating to it an appropriate portion of the variable (direct) costs. Direct costing treats fixed costs (overheads such as administrative and selling costs) as period costs (associated with time and not output). Also called contribution costing or variable costing.

Life-Cycle Costing: Life-cycle costing is a comparative analysis technique that involves summing the total costs incurred during the life cycles of project options to choose the best option. Since starting capital costs may not be an accurate representation of how much a project will eventually cost, life-cycle costing includes all costs associated with ownership — including maintenance and disposal costs — to enable better decision making.

COST MANAGEMENT KPI's to MEASURING PROJECT PERFORMANCE

Once the budget is approved and the project has commenced, there will be a need to benchmark its progress relative to the cost management plan by establishing key performance indicators. These key metrics and performance indicators that may be specified are:

Project Cost Performance: A project's cost performance is an assessment of how actual expenditure on a project compares with planned expenditure as detailed in the project budget. The project manager must indicate a project's cost performance to its stakeholders, which will serve as the foundation for preventative or corrective actions to avoid cost overruns.

Earned Value: Earned Value is a well-established method of measuring project cost performance. It is based on the use of planned value (where a specific portion of a project's budget is allocated to the project tasks) and earned value (where progress is measured in terms of the planned value that is earned upon completion of tasks). By contrasting the earned value with the actual cost, the project has incurred up to a certain point in the project schedule - to see actual project costs compared to expected project costs.

Cost Performance Index (CPI): This is a measurement of how earned value compares to actual cost. This ratio measures a project's cost efficiency at a given point in time by expressing earned value in proportion to actual cost. To calculate CPI, divide earned value by actual cost. A result of 1 means the project is exactly on budget; a number above 1 means it is under budget.

CONTROLLING COSTS

Effective cost control means performing several related activities that all begin by monitoring costs — since you can't know if costs are greater than planned unless you are tracking actual expenses. Then, project managers need to decide how to respond to cost variances. Here are some key steps and concepts that inform the cost control process:

Monitoring Cost Performance: A project manager routinely monitors a project's cost performance by creating

performance reports that summarize current performance and forecast whether you will complete the project on budget. You provide project stakeholders with information about a project's cost performance.

Reviewing Changes: You must amend the cost baseline to reflect all cost-related changes, and you should inform the project shareholders about all changes.

Actual Costs versus Budgeted Costs: Upon milestone and entire project completion, you examine the variances between actual costs and budgeted costs. Responses to the cost management plan will depend on the magnitude of the variance and the stage of the plan - this could range from a discussion to changes in the project scope that reduce costs.

Reserve Analysis: Use reserve analyses to allocate contingency reserves to projects based on the likelihoods and magnitudes of risk.

Cash-Flow Analysis: Used in financial reporting, cash-flow analyses detail cash inflows and outflows over a given period of time, and provide starting and ending balances.

Learning-Curve Theory: The learning-curve theory applies to the relationship between the time spent producing a unit and the number of units produced. According to the theory, the time spent on each unit should decrease as workers gain experience and therefore produce units faster.

COST MANAGEMENT VS. STRATEGIC COST MANAGEMENT

While cost management reduces expenses regardless of their cause or purpose, strategic cost management is a sub-discipline that strives to manage cost while also making the organization stronger.

Robin Cooper, Professor of Management at Claremont's Peter F. Drucker Graduate Management Centre, define strategic cost management as the "application of cost management techniques so that they simultaneously improve the strategic position of a firm and reduce costs."

Strategic cost management centres on the idea that cost reduction initiatives can affect an organization's strategic position. Strategic cost management emphasizes considering the strategic and financial impact of cost management techniques.

Cooper and Slagmulder classify cost management initiatives as one of three types based on how the initiative affects the organization:

Strengthen: An example of an initiative that strengthens competitive positioning is a taxi service that replaces its phone booking system and team of booking agents with an app that allows people to book taxis using their mobile devices. An initiative like this both reduces costs and gives a company a strategic advantage, as it makes it easier to book taxis on short notice.

No effect: An initiative that has no effect on competitiveness might concern a publishing house that outsources proofreading tasks to international freelancers who accept lower wages. While this increases the company's profitability, it does not affect its strategic positioning.

Weaken: Finally, an initiative that actively harms competitive positioning might involve the taxi company decreasing

the frequency of regular vehicle maintenance, a move which, while saving costs initially, will result in cars breaking down more often.

Strategic cost management also comprises a number of important strategies:

Relevant Cost Strategies: Use relevant cost strategies to compare and decide between alternative courses of action. Relevant costs are costs you can reduce by adopting a course of action. They are different from sunk costs (which you cannot recoup once spent) and fixed overhead costs (which are the same for all potential courses of action). When you make decisions, a relevant costs strategy focuses only on costs that vary among options.

Evaluating Opportunity Costs: Evaluating opportunity costs is a more holistic approach to decision making that considers not only all the monetary aspects of alternative courses of action, but also all the intangible aspects. For example, a company providing vehicle repair services might have to decide between two qualities of engine oil, taking into account both that one is more expensive than the other and that the more expensive engine oil also preserves engine health in the long term.

Balanced Scorecard Strategy: A balanced scorecard strategy allows businesses to assess the impact of cost management initiatives across four key areas: financial results, customer impact, internal business processes, and employee growth and development. It provides a framework for thorough consideration of the impacts of cost management initiatives.

COST ACCOUNTING IN PROJECT COST MANAGEMENT

Cost accounting involves the recording and classification of costs associated with a project. It is an internal practice that supports managerial decision making and is a primary discipline concerning cost management.

Cost accounting is different than general financial accounting. Financial accounting concerns reporting an organization's past financial performance and does not delve into extensive detail. Since you carry out cost accounting for a specific area of activity within a company such as a particular project or geographical region — it focuses on more granular aspects and may include projections of future costs.

Cost accounting involves preparing reports for an organization's management (these reports are not distributed externally). By contrast, financial accounting deals with standardized reports that may be distributed to a variety of stakeholders and regulators.

As such, you typically perform cost accounting on an as-needed basis, such as during a strategic project, and it does not follow a mandated format. Financial accounting, on the other hand, is a mandated and regulated formal process, and you must create financial reports according to international financial reporting standards.

There are a few commonly used cost accounting approaches:

Standard Cost Accounting: This is based on the concept of *efficiencies*, or ratios that compare the time and resource costs of actually completing an activity with the costs of completing the activity under standard conditions. Variance analysis is a core element of standard cost accounting. However, since the idea of efficiencies is based on a paradigm in which labour costs contribute substantially to manufacturing — which is no longer the case — standard cost accounting is somewhat outdated.

Activity-Based Costing: This is an approach to assigning overhead costs that examines activities that provide a service, execute a task, or create a product, and then assigns portions of their costs to output.

Resource Consumption Accounting (RCA): This approach emerged around 2000, and assigns costs based on the consumption of resources. It uses a German cost management system known as GPK and activity-based costing, a cost allocation method.

Throughput Accounting: This is an accounting approach that aims to maximize profitability by increasing the rate of production of goal units and minimizing operating expenses and investment costs.

Life-Cycle Costing: This is a method of analysing project alternatives that focuses on total costs of ownership and selecting the most cost-effective option based on more than simple capital costs.

Environmental Accounting: Reporting the environmental costs incurred by a company or project's activities.

Target Costing: This uses a predetermined market price and preferred profit margin to determine how much money can be used to create a product or service. The target cost is the maximum amount you can spend on production without affecting the profit margin.

Cost Coding: To make cost accounting easier, most organizations have adopted a method of identifying costs with a code, usually a number. The root of the code usually represents the type of expense, cost centre, or business unit involved. This makes it easier to group and find related expenses in financial reports. Individual projects may be assigned their own code.

A common structure in an enterprise or very large organization is a top-level, four-digit code that relates to the accounting entity (for example, a subsidiary company). The next numbers pertain to department, followed by a number for the cost, which can be a cost centre, profit centre, work-breakdown-structure element, fund, or internal order. This facilitates the cost management process by aligning the cost codes with the work breakdown structure, which makes it easier to calculate financial performance.

In addition, costs in cost accounting may be classified by:

- **Traceability:** Direct and indirect costs
- **Behaviour:** Fixed or variable costs
- **Controllability:** Controllable or uncontrollable costs
- **Time Incurred:** Historical or predetermined costs
- **Normality:** Normal or abnormal costs
- **Functions:** The organizational function by which you incur a cost

Cost accounts make it easy to identify cost overruns in specific sectors that might otherwise be lost in a budget overview. However, managing many cost accounts up to several hundred accounts and sub-accounts on larger projects — comes with its own challenges. It demands more organization in accounting, for one, and classifying costs becomes more time consuming.

In addition, the system of categorization you use for a project's cost accounts may not match up with the system of categorization you use for an organization's cost accounts. This complicates the creation of a project budget from a final cost estimate and is likely to happen when you create cost accounts using a system of categorization different than the performing organization uses.

Aside from recording historical expenditure, project managers must also forecast expected activity costs to ensure that they remain under control. Managers can do this using tables that classify costs for individual cost accounts and cost modelling techniques that indicate whether work associated with a activity is due to be completed on budget.

SOFTWARE'S ROLE IN PROJECT COST MANAGEMENT

Cost management software simplifies and expedites project cost management activities. This can ease the burden on project cost managers and make it easier to extract insights, such as the cost performance index. Some of the common functionalities include:

Project-Tree Building: A visual representation of a work breakdown structure. This can be useful when employing deterministic estimating techniques.

Cost Estimation: Cost management software can provide powerful estimation capabilities such as using project trees to record activity costs, or running regression analyses to determine cost-estimate relationships in historical data.

Project Cost Management Templates: For projects that are similar, cost management]templates can expedite cost management activities.

Budgeting: Cost management software can make it easier for project managers to conduct budget planning activities and allocate funding.

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Earned Value Performance Techniques

The use of earned value performance for progress tracking in IT software development projects is not fully appreciated by the software industry. For the users of Agile techniques, the concept should be familiar: tracking progress by earned value is like tracking progress through burndown charts the ubiquitous, simple and powerful visuals that are so popular in agile software development.

The two techniques, although developed independently in very different contexts, are similar in terms of their information content. Burndown charts track progress using a "count-down to zero" approach. Remaining work scheduled to be in a future release or project is represented as the sum of features that are weighted using an effort estimate, such as story points or ideal programming days.

Earned value achieves the same effect by adopting a "count up to 100 percent complete functionality" approach. Some experts argue that while burndown charts are emotionally more powerful, they treat planned work as fixed rather than expandable. This limitation makes them less than ideal when the scope changes midstream within the tracking period. The following will be discussed

- **Why Consider Earned Value?**
- **What's Earned Value Management?**
- **Cost and Schedule Variance**

A BASIC UNDERSTANDING OF EARNED VALUE PERFORMANCE MANAGEMENT

Earned Value Performance Management (aka Earned Value, Earned Value Performance, Earned value Management) has been in use for many years. There have been many articles, discussions and questions about Earned Value Performance Management (EVPM). Many of which have been very technical and confusing.

So, what is EVPM? What value is it as a management tool, how can the user benefit from using it? Often, for much of the documentation the explanations are quite complex. Experienced Planners and Schedulers and Project Cost Control specialists' will often talk using technical terms. For example, terms such as Planned Cost (PV), Earned Value (EV), Actual Cost (AC), Cost Performance Index (CPI), Schedule Performance Index (SPI), Cost Variance (CV), To Complete Cost Performance Index (TCPI), Schedule Variance (SV) and the countless number of other indices that are used in definition and discussion of using formulae which can be complex looking. However, to the average Project Manager or project professional who is new to the concepts of Earned Value (EV), this can be very confusing. Moreover, using these acronyms and the focus on the calculation of the indices, the essential meaning of what EVM stands for and its objective can often be overlooked.

By understanding that EVM is a Project Management tool which is used to provide meaningful measures that allow the Project Manager to easily and simply govern the state of the project and ensure control measures exist to control and manage the project EVM data that is produced allows the Project Manager, to get a clear concise view of the current state of the project, and in addition will help mitigate risks whilst driving performance to ensure the project is on track.

EVM is not a complex concept. It is a method of comparing the physical work the project has completed to date against a baseline budget as a measurement of how the project is performing. In simple terms - what was supposed to have been done (Baseline), what is being done now (Actuals and Progress), then how do they compare (EVM indices and variances), and how does that affect where the project will finish (Analysis).

Basically, comparing actual expenditure against the approved budget and not looking at actual physical performance. A common methodology, but this it is only one dimensional. For example, where a project is halfway through in time and has spent 50% of the budget, viewing it simplistically, it could be assumed that the project was on track and be expected to be completed within budget. But what happens if only 40% of the work had been physically completed? With having spent 50% of the budget, this is a very different picture. The project has only "earned" 40% of the budget, but there has been an over spend on the costs to achieve this. Analysis of these two pieces of information indicates that the project will be likely to finish over budget unless corrective action is taken. Additionally, if it was planned to be 50% complete at this time and were only 40% complete, then the project is behind on time and therefore likely to finish later than anticipated. This is the core of EVM.

By converting these calculations to indices, it becomes easier to run down the project Work Breakdown Structure (WBS) and so quickly identify the areas where a non-conformance is occurring. Thus, it becomes easier to manage the project by exception and direct focus to areas where slippage is occurring.

The individual indices are a guide only to quickly determine variances which are meant to be used in conjunction with other project indicators and so requiring further analysis. There may be several reasons

why a project has a low CPI (underperforming) or low productivity. It could be that the project is truly underperforming, and that a mitigation strategy needs to be put in place – but it could also mean that that the baseline was incorrect and that the physical progress measurement does not truly reflect physical effort, or that the project is using cheaper resources that spend more hours but save in cost, or it could mean there is additional scope that has not been through change management yet. Never the less it is a reason for further analysis to determine what is truly happening. By understanding the root cause of variances an appropriate corrective action plan may be developed

The core of EVM – is to generate performance metrics and reports but itis not the end of the process. EVM is a tool by which variances can be identified and as such these metrics are the start of the process of analysis and mitigation. These EVM metrics are a tool for control and like any tool there needs to be clear instructions in place to use it correctly. In project terms, this means that there are a few fundamentals that must be correct to get the most out of this methodology.

The baseline budget must be clearly defined and broken down in a manner to reflect how the work will be delivered. This will quite often mean extracting a tender estimate and reworking it until there is an adequate performance baseline. This stage is critical because it will be the yardstick that you will measure yourself against on the project. Breaking the work down into design work packages, construction packages and / or by discipline or commodity will allow the production of metrics to see how each area is performing and to produce targeted performance metrics for each package / team leader.

The method of obtaining good physical progress must reflect the physical effort to do the work. Whether this be quantities installed, in the case of pipelines, pumping stations and other construction work, or deliverable milestone gates which is common to many organisations work or business case need to reflect the effort and budget required to do the work. It should not, for example, reflect payment milestones, time-based progress or an estimate of progress achieved.

Actuals and progress data must be collected in a timely matter each month. The essence of earned value management is to provide timely information to quickly identify variances and implement corrective actions.

There also must be a mature change management process in place to identify changes in scope or trends which may impact on cost of completion. Identification of changes in scope is critical. EVM is all about comparing what was supposed to be done against what is occurring. If the initial scope (what the project is supposed to do) has changed then the change management process must initiate to capture this so there is a constant comparison of progress to a relevant baseline or approved budget.

In summary, EVM is a valuable tool for all Senior Project Managers. By not implementing it, the focus of Project Management will stray from the overall health of the project and be lost in the day-to-day problems.

The strength of EVM lies in its capability to act as an early warning system and thus providing clear analytical data that allows the Senior Project Manager to identify areas of concern. Linked with further analysis, it allows the basic cause of problems to be identified which results in realistic corrective action plans being developed, allowing the Senior Project Manager to remain focused on delivering the project.

EARNED VALUE PERFORMANCE MANAGEMENT TERMS AND FORMULAS FOR AN ICT PROJECT

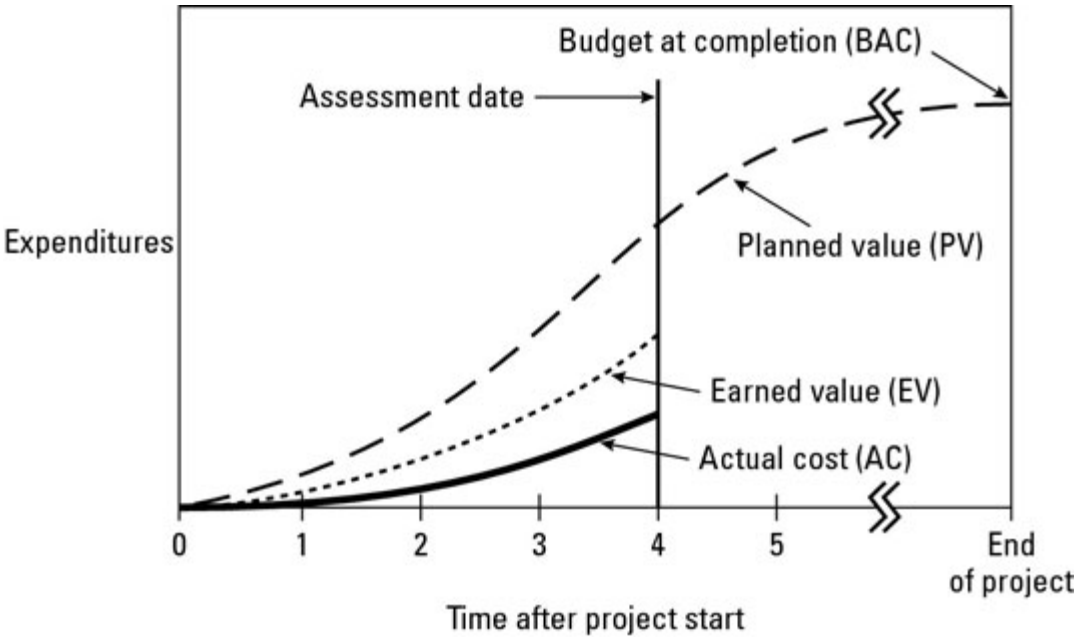
The basic premise of Earned Value Performance Management (EVPM) is that the value of a piece of work is equal to the amount of funds budgeted to complete it. As part of EVPM, use the following information to assess the schedule and cost performance throughout the project.

Planned Value (PV): The approved budget for the work scheduled to be completed by a specified date; also referred to as the Budgeted Cost of Work Scheduled (BCWS). The total PV of a task is equal to the task's Budget at Completion (BAC) — the total amount budgeted for the task.

Earned Value (EV): The approved budget for the work completed by the specified date; also referred to as the budgeted cost of work performed (BCWP).

Actual cost (AC): The costs incurred for the work completed by the specified date; also referred to as the Actual Cost of Work Performed (ACWP).

Monitoring the project's performance involves determining whether it is, on, ahead of, or behind schedule and on, under, or over budget. But just comparing the actual expenditures with the budget can't tell you whether it is on, under, or over budget — which is where EVPM comes in.



MONITORING PLANNED VALUE, EARNED VALUE, AND ACTUAL COST.

To describe the project's schedule and cost performance with EVPM, use the following indicators:

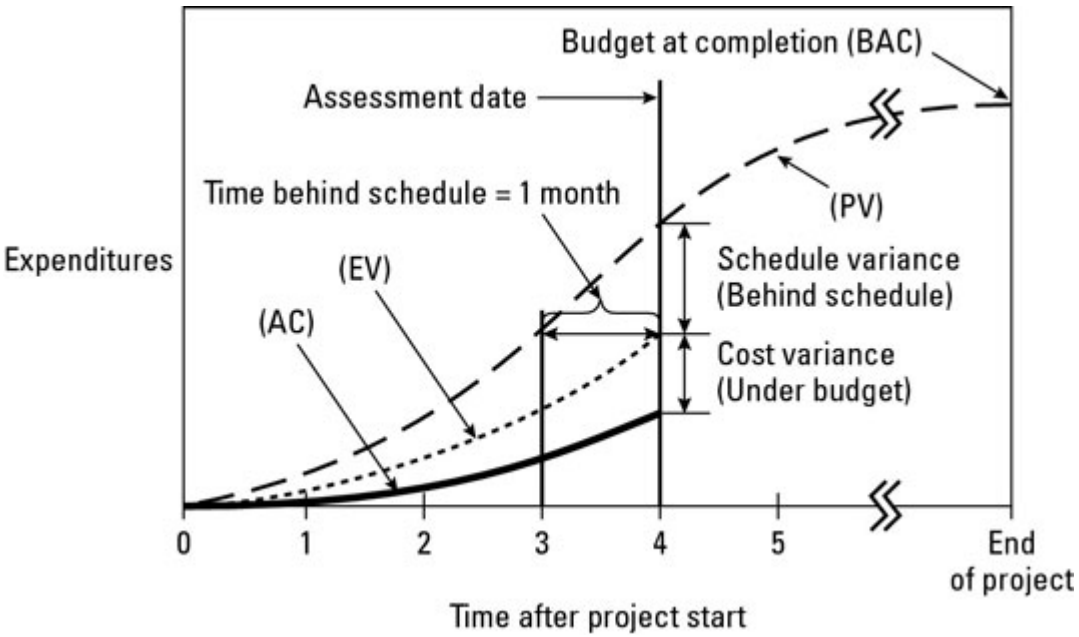
Schedule variance (SV): The difference between the amounts budgeted for the work achieved did and for the remaining work planned to completion. The SV shows whether and by how much the work is ahead of or behind the approved schedule.

Cost variance (CV): The difference between the amount budgeted and the amount spent for the work performed. The CV shows whether and by how much under or over the approved budget.

Schedule performance index (SPI): The ratio of the approved budget for the work performed to the approved budget for the work planned. The SPI reflects the relative amount the project is ahead of or behind schedule, sometimes referred to as the project's schedule efficiency. Can use the SPI to date to project the schedule performance for the remainder of the task.

Cost performance index (CPI): The ratio of the approved budget for work performed to what has been spent for the work. The CPI reflects the relative value of work done compared to the amount paid for it, sometimes referred to as the project's cost efficiency. Can use the CPI to date to project the cost performance for the remainder of the task.

Can approximate the amount of time that the project is behind or ahead of the approved schedule by drawing a line from the intersection of the EV and assessment date lines parallel to the x-axis to the PV line. Doing so suggests that the project being described by the graph is about one month behind schedule.



THE DIFFERENCE BETWEEN PLANNED AND ACTUAL EXPENDITURES UP TO THE DATE OF THE REPORT IS THE RESULT OF BOTH A SCHEDULE DELAY AND COST SAVINGS.

Schedule and cost variances and performance indicators are defined mathematically as follows:

- Schedule variance (SV) = Earned value (EV) – Planned value (PV)
- Cost variance (CV) = Earned value (EV) – Actual cost (AC)
- Schedule performance index (SPI) = Earned value (EV) / Planned value (PV)

- Cost performance index (CPI) = Earned value (EV) / Actual cost (AC)
-

The final step when assessing task performance to date is to update what the expected total expenditures will be upon task completion. Specifically, need to determine the following:

- Estimate at completion (EAC): Your estimate today of the total cost of the task
- Estimate to complete (ETC): The estimate of the amount of funds required to complete all work remaining to be done on the task
-

Use the following two approaches to calculate the EAC:

Method 1: Assume that the cost performance for the remainder of the task will revert to what was originally budgeted.

- EAC = Approved budget for the entire task – Cost variance for the work done to date on the task
  = Budget at completion (BAC) + Actual cost (AC) – Earned value (EV)

Method 2: Assume that the cost performance for the remainder of the task will be the same as what it has been for the work done to date.

- EAC = Budget at completion (BAC) / Cumulative cost performance index (CPI)

Whether you use Method 1 or Method 2 to calculate EAC, ETC is determined as follows:

- ETC = Budget at completion (BAC) – Actual costs to date (AC)

CORE COMPONENTS OF AN EVM PROCESS

The production of EV data requires that a performance measurement baseline, drawn directly from the project plan, comprising of the following:

- The Performance Measurement Baseline (PMB). The PMB consists of a time-phased aggregation of the (people and material) resources (expressed in budgetary terms) required to execute the work scope of the project, usually in a Work Breakdown Structure (WBS) and within which EVM analysis would be performed. The PMB is often shown as a cumulative X/Y curve (as in the above diagram) – this is the 'baseline' against which cost, and schedule performance is compared using EVM metrics. The full PMB also include and define how Earned Value will be measured and taken through the life of the project.
- Objective Measures of Progress is that progress must be assessed periodically – there are several ways of doing this and the overarching rule (backed up by a mass of evidence) is that the more subjective the methods are, the less reliable the EVM data is likely to be and the greater space there is for unwanted 'surprises' downstream
- Actual Costs – Labour and Materials: Actual cost data must then be gathered against by the elements in the PMB – this requires that business systems and processes enable useful and timely capture of actual cost data, via the structures that are employed in the EVM system – not something that falls naturally from all business systems.

EVM was not developed simply to report status to the client – it may be used in this way, but if this is the only way it is seen, a huge degree of the value of using the method will be lost.

The objective is to embed EV data into the practice of daily management of the project, leading to an improvement in decision-making based upon an informed analysis of real status against cost and schedule goals, at the working levels of the project.

Organisational Implementation Challenges

For organisations implementing Earned Value Management, the challenge lies not just in the procedure of the method, but more importantly in the corporate cultural change required to reinforce an EV based project control system.

Often, when most organisations initially attempt to use EVM, they typically find that it highlights weaknesses or gaps in the project planning and control processes and capabilities. For example:

- a robust baseline must be developed as quickly as possible once the contract has been awarded – a task which challenges many organisations – and then it must be maintained
- the planning process must identify all major project deliverables clearly, within the PMB, not just the functional effort assumed to be required to deliver a project
- objective measures of physical progress must be assessed routinely
- business systems and processes need to provide data in a timely manner (e.g. costs) and need to be structurally compatible with the needs of the EVM system
- and finally, after several decades of evidence shows that when permitted to, people will find countless numbers of ways to manipulate EVM results to hide bad news, erroneously in the expectation of giving themselves time to make the 'issue' go away – typically what this does is to reduce the focus, resource and effort on the issue, quite possibly until it becomes irreversible. The good news is that this can be spotted quite easily and prevented, if we choose to.

Is Earned Value worth the effort?

This question has caused considerable anguish in some environments for many years. EV gives objective measures of status against the cost and schedule goals of a project; there are no more primary or fundamental goals in project management. Assuming an organisation follows the principles that underpin good practice in EVM systems, it provides important data to project teams, without which teams can operate in a vacuum regarding their performance, or even worse, they could operate in an environment of false optimism that does not see the level of challenge or issues in their project, until it is too late to make a real impact on the same something that occurs far too often in projects.

Earned Value is not just worth it, it is a fundamental tool to being in control in large scale risky development programmes.

Creating an EV Requirement

Customers increasingly require contracts to be pro-actively controlled to assure delivery on time, to budget and to specification. Customers look for confidence in the project status information being supplied and are increasingly achieving this by defining contractual agreements that require EV to be used by their suppliers.

The major considerations include:

- defining and communicating the EV requirement including the incorporation of the Integrated Baseline Review process

- assessing the merits of payment by EV
- determining appropriate data access and reporting requirements
- defining and agreeing on performance review cycles and processes

The Integrated Baseline Review?

The purpose of an Integrated Baseline Review (IBR) is via a surveillance methodology to assess a set of EV processes and to confirm the completeness and fitness-for-purpose of the project's Performance Measurement Baseline. Where it is important to have confidence at an early stage that the baseline plan for a project is realistic, an Integrated Baseline Review may be deployed.

Preparing for an Integrated Baseline Review (IBR)

If an Integrated Baseline Review is required to be performed, it will require preparation and the attention of those who will participate in the review. As a minimum, the following should be agreed / prepared before the review:

- agreement on the specific objectives of the review and exit criteria
- the scope and timing of the review and how it will be conducted
- documentation and personnel to be made available at the review.

IBRs are often preceded by some form of readiness review – given that an IBR should be held as soon as possible and practical following contract award, the scheduling and resourcing of these activities needs to be considered urgently from contract award onward.

APPENDIX 1 – THE ORIGINS OF EARNED VALUE PERFORMANCE MANAGEMENT

> There is nothing more difficult to plan, more doubtful of success, nor more dangerous to manage than the creation of a new system. For the imitator has the enmity of all who would profit by the preservation of the old institutions and merely lukewarm defenders in those who would gain by the new
>
> Niccolỏ Machiavelli, The Prince

For many years the project management techniques that have been used extensively for the management of projects of all sorts, shapes and size: have tended to focus on achieving deadlines by controlling (initially) the use of time and then resources. The most common reports would be centred around "Milestones" showing time-based progress reporting of the "Current Status" versus the "Original Planned Status" based on resources used. This of course only showed part of the picture, the use of time and resources whilst being valuable information, did not provide management with a full view of the project, what was missing, was the "Value" of the work done.

The concept of work having a value has been around for over sixty years and has been known by a series of popular acronyms, for example: EVA (Earned Value Analysis), CS² (Cost/Schedule Control Systems Criteria), EVPM (Earned Value Performance Management). Despite software tools being available that would carry out Earned Value computations, it was considered too complicated by most IT project managers. However, with the increasing number of projects failing to meet time or budget expectations, the project management market is examining ways to improve project delivery. Having noted that those projects, which have utilised the EVA method, have been successful in delivering the project that the stakeholders expected, the project management community is beginning to make moves towards the use of Earned Value techniques.

However, many project managers within the wider project community see earned value as being a method that is mandated by the department of defence. There is now a current move the technique from the government arena and make it available to the wider project market. To this end, the existing definitions of how an Earned Value system should be established are being redefined by Standards Australia. (see AS4817:2006) What is EVPM? It is basically a way of understanding how a project is performing. It is a simple way of progress monitoring and forecasting completion.

Basic Cost Control

Obviously, it is very important to know on a project how it is progressing in terms of time and cost. Usually there will be a "Target Plan", that is a document that shows the original plan. If each task is allocated a cost, then a cash flow curve can be prepared. The "Target Plan" shows how the project is intended to go and the cash flow curve how the money is expected to be spent.

Each progress period (weekly or monthly), the actual costs are plotted on the cash flow curve to compare what has been expended to what was intended. An example of such a cash flow is shown in Figure 1.

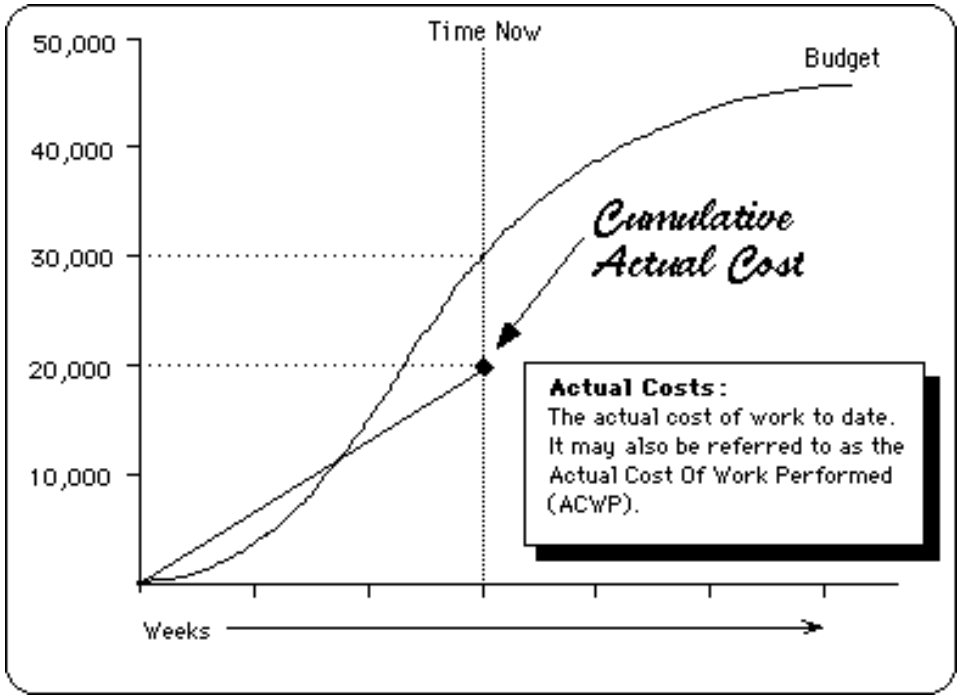


Figure 1: Original Cash Flow and Actual Cost Curves

Figure 1 indicates that the actual expenditure on the project is not keeping up with the original plan. The project manager is now faced with the dilemma of what the data means. One reason for the apparent decline in expenditure could be that a more efficient or less expensive way has been found to carry out the work. If this is the case, then the project undoubtedly will be completed on time and under budget! Of course, there are many other explanations equally likely, but this simple illustration shows how difficult the project manager's job can be in totally knowing what is going on.

Earned Value Performance Management

Time reporting and the actual cash expended to date do not in themselves provide a measure of the "Value" of the work achieved. Earned Value Performance Management provides the solution. EVPM is a technique that permits the project manager to compare the 'value' of the work completed to date with the "value" of work originally scheduled. Basically, EVPM suggests that the value of the physical work achieved (known as the Budgeted Cost for Work performed – BCWP) is compared with the value of the work that should have achieved (known as the Budgeted Cost of Work Scheduled – BCWS). The actual amount of work achieved at a given date is measured and multiplied by the cost rates used to produce the budget. It is not necessary to know how much has been spent, just the amount of work Achieved and the value of that work.

This process is carried out for each task, total groups of tasks and a total of all the tasks for a project overview. This approach has many advantages, only the physical amount of work achieved must be measured, in most industries this is easy. Because like is being measured with like it is very quick to produce the result on just how the project is going. In fact, a single piece of A4 paper can show just how the project is performing. By adding in the actual costs to date for each task (the Actual Cost for Work Performed – ACWP (now known as

Actual Cost (AC), it is possible to produce a series of ratios each of which provides an indication as to the state of the project.

The originally named BCWP is also known as the "Earned Value - EV", it is calculated by multiplying the original budget value for each task with the progress reported to date. The great benefit of this is, is that there is no waiting for the accounts department to catch up with the information. Meaningful reports can be produced quickly showing the status of the project on one page. Time is reported by Milestone reports and EVPM reports value.

The capacity to account for actual costs, that is, the "Actual Cost" – (AC) affords the project manager with a view of the full cost picture. From this information two major ratios may be calculated, these are "Scheduled Variance" (SV) which tells the project manager (based on original budget costs), the actual value (or quantity) of work performed against the original plan. The Scheduled Variance is computed as follows; -

$$SV = EV - PV$$

Schedule variance is illustrated below in Figure 2, along with Schedule Slippage, which indicates how far behind in terms of time, when the value of work to be performed should have taken place.

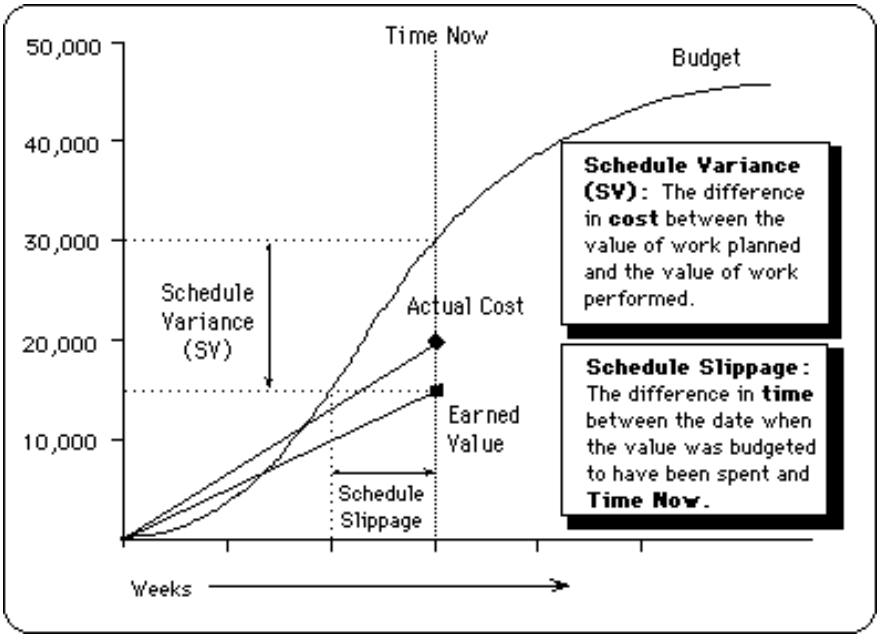


Figure 2 Schedule Variance and Scheduled Slippage

Schedule slippage indicates to the project manager that unless corrective action is implemented as quickly as possible then the final project completion date will be delayed by that amount.

The second ratio is the "Cost Variance" (CV), which is also known as the "Cost Performance Index" (CPI). This ratio compares the actual cost for performing the work completed to date against the original budget value (plus or minus variations) for that work. Thus, answering the question is the work that is being achieved, being performed in a cost-effective manner. The Cost variance is computed as follows: -

$$CV = EV - AC$$

Figure 3 below illustrates the cost variance and clearly shows that the project is currently running behind in both schedule and costs. Without the EV and AC, management, if it were just looking at the budget curve would have no indication as to how far behind the project is at Time Now.

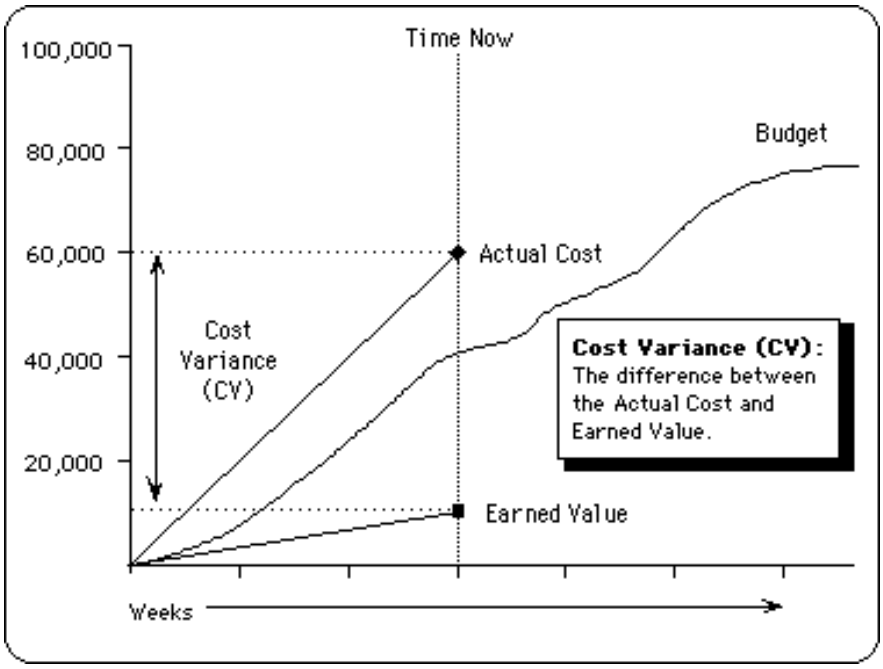


Figure 3: Cost Variance

In addition to understanding the situation at Time Now, the project manager needs to understand what the implications of progress to date have on the projected completion date and the value to completion of the project. This gives rise to another set of ratios and values, which are calculated, from Time Now; these are "Budget at Completion" (BAC), "Estimate to Complete" (ETC), "Estimate at Completion" (EAC), "Variance at Completion" (VAC). Figure 4 below shows each of the ratios as defined in the Earned Value Performance Management technique.

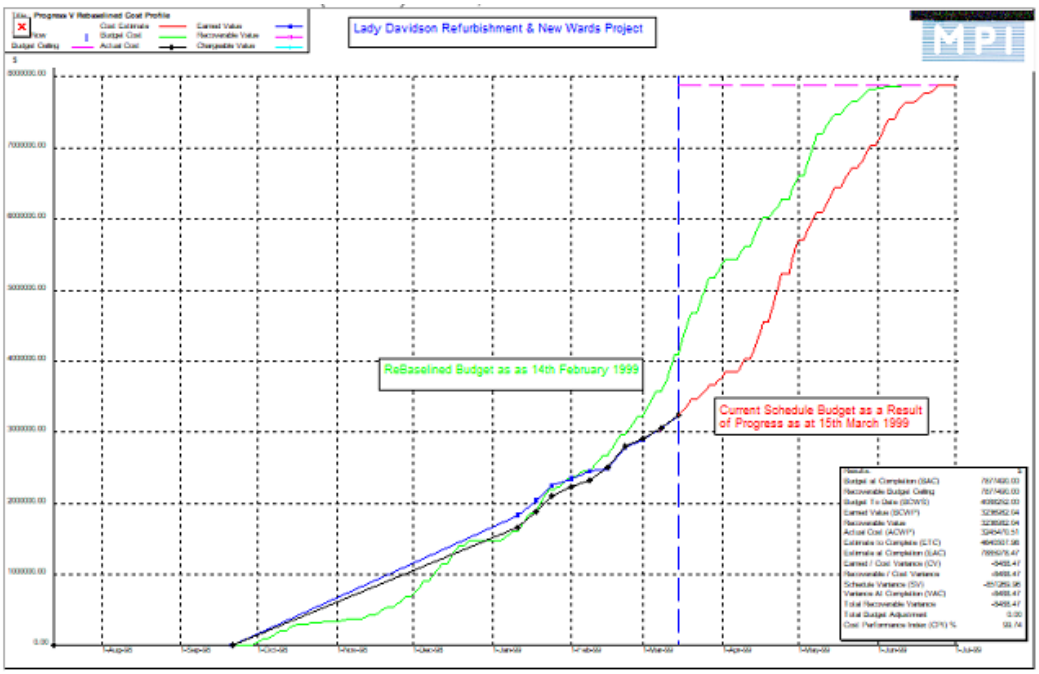


Figure 4: EVPM Curves and Ratios

The EVPM Terms Explained

The following is a simple and concise explanation of the various acronyms (factors) and ratios used in EVPM. Usually a computer program is used to calculate these factors.

Planned Value PV originally known as BCWS – Budgeted Cost of Work Scheduled
PVs the VALUE of the work that SHOULD have been accomplished at a given point in time. This takes the work PLANNED to have been done and the budget for each task indicating to you what part of the budget you planned to have used.

Earned Value EV originally known as BCWP – Budgeted Cost for Work Performed
EV is the VALUE of the work you HAVE accomplished at a given point in time. This takes the work that HAS been done and the budget for each task indicating to you what part of the budget you ought to have used to achieve that.

Actual Cost AC originally known as ACWP – Actual Cost for Work Performed
AC is the ACTUAL cost of the work done.

SV – Schedule Variance
SV is the value of the work you HAVE accomplished minus the value of the work you SHOULD have accomplished (EV – PV). A negative value indicates that you are behind schedule in monetary terms.

CV – Cost Variance

CV is the budgeted cost of work accomplished to date minus the actual cost of work accomplished to date (EV – AC). A negative cost variance indicates the current budget overrun. CV greater than 0 is good (under budget).

BAC – Budget at Completion

BAC is the original budget for the whole project from start to finish.

EAC – Estimate Cost at Completion

EAC is the revised prediction of how much the project will cost (considering what has been spent so far and the current estimate to complete the remaining work). EAC is the manager's projection of total cost of the project at completion. This formula assumes, that the performance of the project (or rather a deviation of the actual performance from a baseline) to date gives a good indication of what a performance (or rather deviation of a performance from a baseline) will be in the future. In other words, this formula is using statistics of the project to date to predict future results. Therefore, it has to be used carefully, when the nature of the project in the future is likely to be different from the one to date (e.g. performance of the project compare to baseline at the design phase may not be a good indication of what it will be during a construction phase).

ETC – Estimate to Complete

ETC is the estimated value required to complete the remaining work. ETC must be based on objective measures of the outstanding work remaining, typically based on the measures or estimates used to create the original planned value (PV) profile, including any adjustments to predict performance based on historical performance, actions being taken to improve performance, or acknowledgement of degraded performance.

While algebraically, ETC = EAC-AC is correct, ETC should *never* be computed using either EAC or AC. In the following equation, ETC is the independent variable, EAC is the dependent variable, and AC is fixed based on expenditures to date. ETC should always be reported truthfully to reflect the project team estimate to complete the outstanding work. If ETC pushes EAC to exceed BAC, then project management skills are employed to either recommend performance improvements or scope change, but never force ETC to give the "correct" answer so that EAC=BAC. Managing project activities to keep the project within budget is a human factors activity, not a mathematical function

VAC – Variance at Completion

VAC is the difference between the original budget and the latest revised budget (BAC-EAC). If the value is negative, it indicates an anticipated cost overrun.

CPI - Cost performance index

CPI greater than 1 is favourable (under budget):

< 1 means that the cost of completing the work is higher than planned (bad);

= 1 means that the cost of completing the work is right on plan (good);

> 1 means that the cost of completing the work is less than planned (good or sometimes bad).

Having a CPI that is very high (in some cases, very high is only 1.2) may mean that the plan was too conservative, and thus a very high number may in fact not be good, as the CPI is being measured against a poor baseline. Management or the customer may be upset with the planners as an overly conservative baseline ties up available funds for other purposes, and the baseline is also used for manpower planning.

To-complete performance index (TCPI)

The TCPI provides a projection of the anticipated performance required to achieve either the BAC or the EAC. TCPI indicates the future required cost efficiency needed to achieve a target BAC (Budget At Complete) or EAC (Estimate At Complete). Any significant difference between CPI, the cost performance to date, and the TCPI, the cost performance needed to meet the BAC or the EAC, should be accounted for by management in their forecast of the final cost.

For the TCPI based on BAC (describing the performance required to meet the original BAC budgeted total):or for the TCPI based on EAC (describing the performance required to meet a new, revised budget total EAC):

This implies, that if revised budget (EAC) is calculated using Earned Value methodology formula (BAC/CPI), then now, when TCPI based on EAC is first time calculated, it will always be equal to CPI of a project at that moment. This happens because when EAC is calculated using formula BAC/CPI it is assumed, that cost performance of the remaining part of the project will be the same as the cost performance of the project to date.

Independent estimate at completion (IEAC)

The IEAC is a metric to project total cost using the performance to date to project overall performance. This can be compared to the EAC, which is the manager's projection.

HISTORY OF EARNED VALUE MANAGEMENT (PREVIOUSLY KNOWN AS OR COST/SCHEDULE CONTROL SYSTEMS CRITERIA)

The Earned Value process (Cost/Schedule Control Systems Criteria) was a set of 35 criteria (for a full description of these see Appendix 1) for measuring the adequacy of management control systems through, among other things, the application of earned value performance management concepts. These criteria were adopted by the U.S Department of Defence for large value projects as a means of keeping, the then, ever escalating cost overruns on major projects under some sort of control. It was originated as Department of Defence Instruction 7000.2 on April 25P^{thP} 1968 (which at the time of updating this paper October 2018 makes it over 50 years old!). The objectives of this DoDI were stated as follows:

1) To provide an adequate basis for responsible decision making by both contractor management and DoD Components, contractor's internal management control systems must provide data which

- indicates work progress,
- properly relates cost, schedule and technical accomplishment,
- are valid, timely and auditable, and
- supply DoD managers with information at a practicable level of summarization.

2) To bring to the attention of, and encourage, DoD contractors to accept and install management control systems and procedures, which are most effective in meeting their requirements and controlling contract performance. DoD contractors also should be continuously alert to advances in management control systems, which will improve their internal operations.

In recognition of the benefits apparent from the application of C/SCSC back in 1986/1987 the Australian DoD on the then the advent of ANZAC Frigate Project, the Collins Class Submarine Project, JORN (Jindalee Over the Horizon Radar) and the Jindivick refurbishment program, caused the issue of a policy statement for the application of C/SCSC to selected Defence Capital Equipment acquisition projects.

EVPM in the 80's and 90's

In 1991 US DODI 5000.2 superseded US DODI 7000.2, then in 1996 DoD Regulation 5000.2–R, superseded DODI 5000.2 and it was during this time that the name of the methodology gradually changed from Cost/Schedule Control Systems Criteria to Earned Value Performance Management. However, after twenty-

three or so years the criteria had remained essentially the same. The 1991 change dropped three of the original criteria. It is interesting to note that in 1996 the British Standards Institute in its BS 6079:1996 Guide to Project Management has adopted the criteria laid out in DODI 5000.2.

The 1991 US DODI 5000.2 formed the basis for the Def (AUST) 5655 issued in October 1992 when the initial major Australian thrust into CS was established, the then Department of Project Management System within DoD developed an Australian version of CS². These were generated from the US DoDI and were numbered and titled as follows: -

- Def (AUST) 5655 – Australian Cost Schedule Control Systems Criteria
- Def (AUST) 5657 – Australian Cost Schedule Control Systems Criteria; Implementation Guide (ACSIG)
- Def (AUST) 5658 – Cost Schedule Status Reporting (CSSR) Specification and Implementation Guide
- Def (AUST) 5664 – Work Breakdown Structures for Defence Materiel projects – Policy and Guidance

The Australian DoD policy stated that all projects (including subcontracts to eligible prime contracts) that are over $100m in value (including multiple subcontracts to one prime contractor) or projects / subcontracts over $40m that include a significant development component will use C/SCSC techniques. Thus, during the early 1990's there was an upsurge in defence contractors attempting to bring their internal control systems into line with the Australian standards.

Consequently, the then traditional hierarchical structures gave way to flat management organisations with much of the responsibility for completing the project resting with the various Cost Account Managers (CAM) in the organisation. However, before we can discuss the role of the CAM, we need to understand how developing the project Work Breakdown Structure derives Cost Accounts.

It is worth noting that many of the major banks at this time were rewriting their legacy banking systems and used Earned value techniques as promulgated by Australian DoD to manage that process

Work Breakdown Structure & Organisation Breakdown Structure

EVPM sets out to monitor and control many variables; however, the two major breakdowns for any project are the Organizational Breakdown Structure (OBS) and the Work Breakdown Structure (WBS). The WBS techniques were originally defined in the U.S. Military Standard 881A, which in Australia is known as Def (AUST) 5664. Establishing the WBS provides the structure for the basic planning, scheduling and budgeting process. The OBS establishes the 'line of authority' structure within the project. The contractor on winning a bid must provide, among many other items, the following: -

1) A schedule of authorised work, which describes the sequence of work and identifies the significant activity interdependencies required to meet the development, production and delivery requirements of the contract.
2) Identification of physical deliverables, milestones, technical performance goals, or other indicators that will be used to measure output.
3) A time-phased budget baseline at the cost account level against which contract performance can be measured.

4) Budgets for all authorised work with separate identification of cost elements (e.g. labour, materials, equipment, etc.)
5) An OBS Chart.

Once the baseline schedule (cost and budget) has been agreed, EVPM imposes rigorous requirements on the Contractor to furnish information accounting for direct and indirect costs and a summarisation of costs rolling up through the WBS. In addition, the contractor has to provide detailed analysis of time, resources used, costs, materials, overruns and scope change; all in all not an easy task.

The Def (AUST) 5664, provides for a standard Work Breakdown Structure of the upper three (summary) levels of a WBS and has a uniform element terminology, definition, and placement structure in the family tree. The upper three levels of a summary WBS have been organised to cover seven categories of defence projects, these are: -

1) Aircraft Systems
2) Electronic Systems
3) Missile Systems
4) Ordnance Systems
5) Ship Systems
6) Space Systems
7) Surface Vehicle Systems
8) Information Technology

The top three levels of the WBS are defined as follows: -

- Level 1 is the entire defence item, for example the LHA Ship System, or the Anzac Frigate Project.
- Level 2 are the major elements of the defence item, for example, a frigate or a submarine.
- Level 3 elements are subordinate to level 2 major elements, for example, an electric power plant or an airframe.

Figure 5 below, illustrates the standard WBS for a typical ship construction

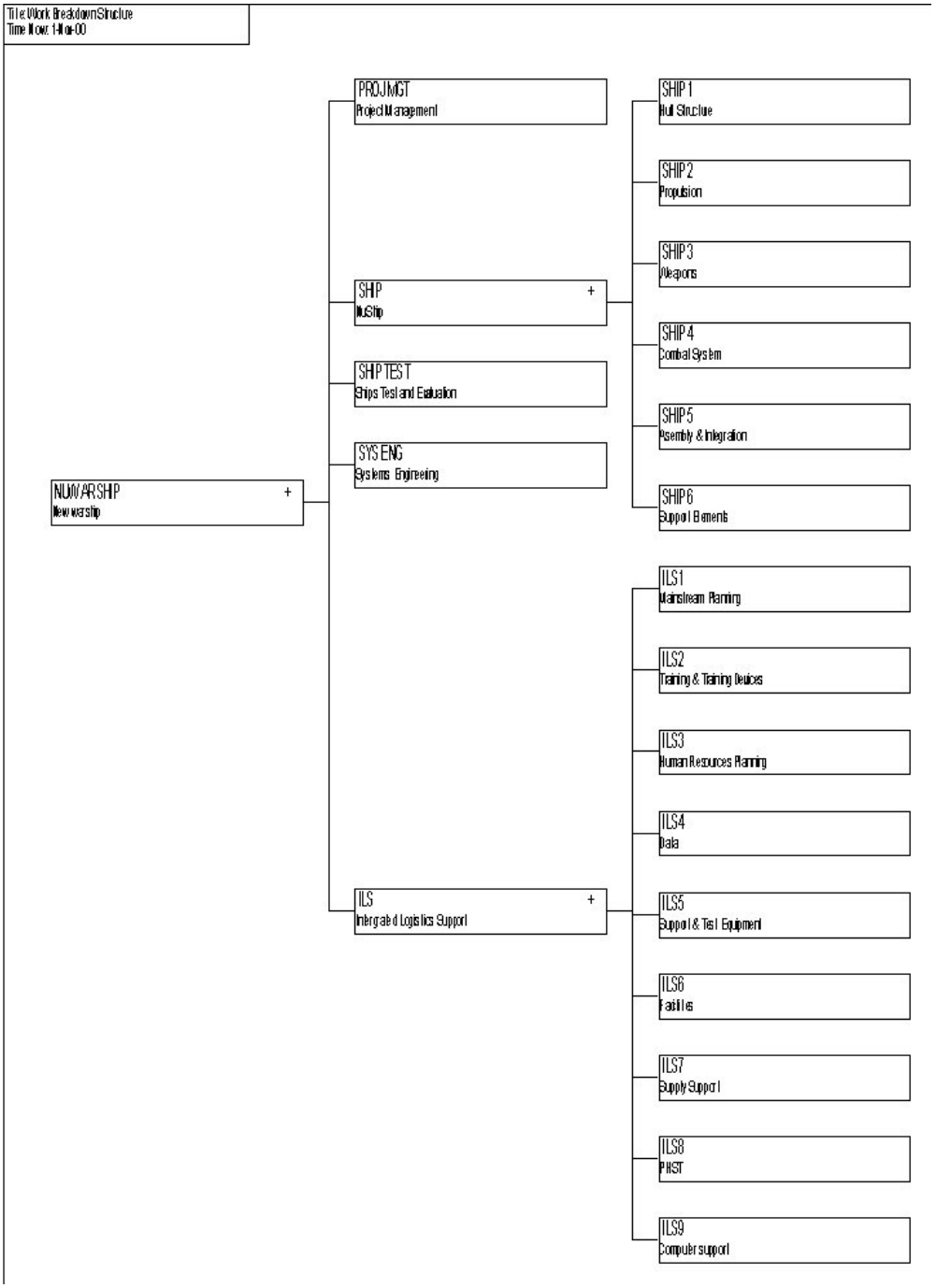


Figure 5: WBS for Typical NuShip Construction

In addition, the contractor must furnish information on configuration items, systems engineering, logistics engineering, integrated logistics support, acquisition and finally how the elements will be integrated and assembled. The OBS follows a similar pattern to the WBS but is less standardised due to the wide range of different management structures within various companies. Whilst developing this massive amount of systems information it must not be forgotten that all the elements are subject to the most stringent quality control.

Cost Accounts

From the WBS and OBS, the individual "Cost Accounts" (CA) are derived. Each CA is managed by a "Cost Account Manager" (CAM) and in my view of EVPM the role of the CAM is central to the whole management process. Each Cost Account Manager is responsible for the completion of a major component (or process) of the project within specified quality, cost and time constraints. Naturally as each CAM is responsible for meeting the completion deadlines for his/her section of the project, they are all entitled to control the project planning processes within their CA.

Figure 6 below shows a typical Cost Account Chart. Each Cost Account is at the intersection of a WBS element and an OBS element (person), although it is obvious that each intersection does not of itself constitute a CA. Each CAM may be responsible for one or more CAs and one or more CAs may require completing to make up a full WBS element, the final structure being dictated by the realities of the project.

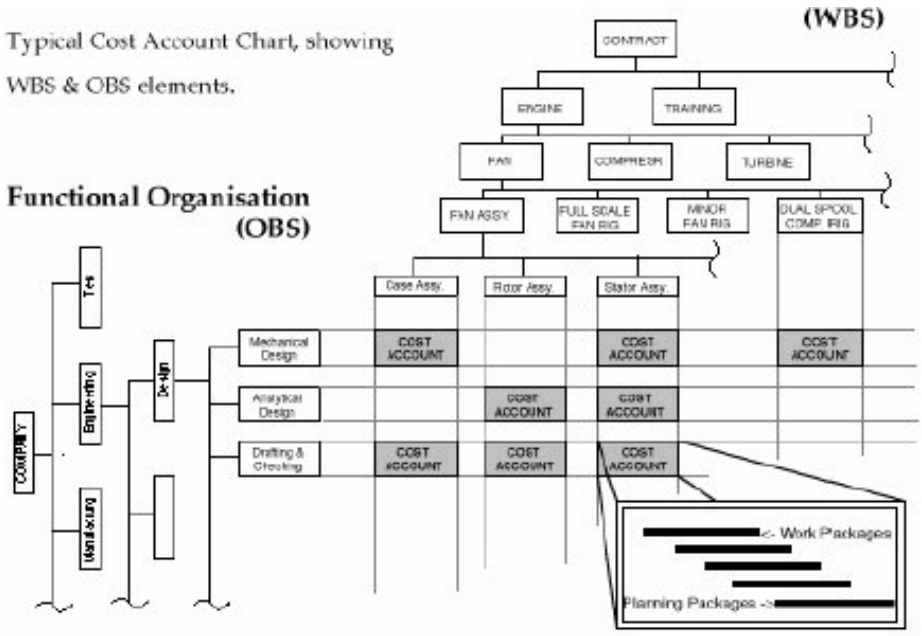


Figure 6 Cost Account Chart

The individual CAs are further divided into a series of "Planning Packages" and "Work Packages". Planning Packages are turned into Work Packages as time progresses and enough information is available for a detailed schedule and budget to be established. Ideally Work Packages only extend 6 - 9 months into the future, everything beyond that remaining as a Planning Package. Each Planning Package has a predefined budget, schedule, milestone(s) and scope of works. On development projects, the details of CAs and Planning Packages later in the contract may not be known until after the completion of design work (i.e. other Work Packages or Planning Packages) earlier in the project and may simply be "blocked in" as a general allowance with details being added as they become known.

A significant number of the 35 C/SCSC criteria relate to the management and control of the financial reporting process, change orders, budget variations, contingencies and quality standards, however, these items, remain the responsibility of the CAM. My intention is to examine how the project scheduling systems need to be managed to serve the requirements of the project, the individual CAM and remain current in a steadily changing environment.

PROJECT PLANNING UNDER EVPM

THE PLANNING CHALLENGE

EVPM presents the project manager with a series of interesting and complex problems: -

1) The essence of EVPM is to push management control down to the CAM but the contractor is required to report to the Client, in an effective way, summary information relating to the whole project.
2) Well ahead of the appointment of many of the CAM, there is a requirement to develop the baseline schedule for the whole contract, yet each CAM, if (s)he is to work efficiently must have schedule control over the work involved in completing each work package within their CA.
3) In parallel with these requirements there is an additional need to provide departmental management capabilities so that the competing demands of several CAM from within the same department can be adjudicated. To further complicate this aspect of the planning, each department may have CAM working on several different projects, fighting for resources from the same pool.
4) To be effective, the overall planning process must maintain data integrity up and down the system and needs to minimise the double entry of information. At the same time, simply consolidating data from lower levels in the planning system is not acceptable as any errors at the CA level will be passed straight through to corporate reports and more senior management may wish to demand changes in the current CA plan before accepting the information.
5) The project planning team needs to be capable of working for many different masters who will often have different objectives whilst maintaining common standards and methods.

The challenge of the planning system is to meet all the above requirements without becoming overly complex.

One way to resolving these problems has been to set up a tiered planning structure, as shown in Figure 7.

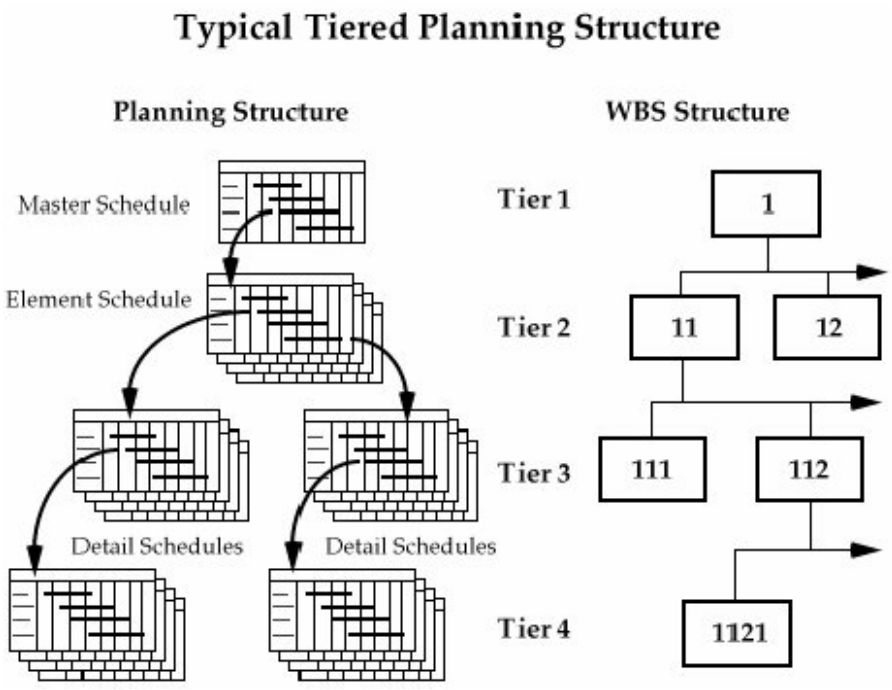


Figure 7. Tiered Planning Structure

Basically a waterfall approach to establishing the project planning

However, I advocate a slightly different approach to exploit the facilities offered by the current range Project Management software.

At the top level, the Master Schedule can become a summary produced from within the Programme Element schedule utilising Hammocks, rather than a separate programme. The Programme Element Schedule, however, maintains its traditional role with each activity on the Element Schedule relating to a single Cost Account (or identifiable section of a CA) and is used to map the interaction of schedule changes between different CAs, including external subcontractors. The role up requirements of the WBS system is then largely controlled within the Master Programme as discussed below.

At the CA level a series of small to medium sized project programmes exist, at least one per Cost Account. However, to be effective all the individual CA programmes need to be dynamically linked at key points so if the deliverable elements from one CA change, e.g. If documentation is late from one CA, the corresponding training course (requiring the Documents for its students) is delayed within the other (Training) CA. The third element in the matrix is to be able to merge all the detailed requirements for resources from several different CA programmes into one Departmental Control Programme to ensure the Department has all of the necessary resources to meet all of its obligations. If insufficient resources are available, revised schedule data needs to be passed back from the Departmental schedule to the CA programme and then up to the Programme Element schedule.

Many years ago, to achieve all these requirements was almost impossible and required extensive manual effort. However, the advances in Project Management Software have now made an integrated system not only possible but also a very practical proposition.

The MASTER PROGRAMME

The Master Programme is the start of the process, along with defining the project WBS and OBS. Once the Master Programme, with its Elemental Schedule, Milestones and WBS are complete the Contractor can establish his baseline schedule for the project in terms of both time and cost. This should be based on Adjusted Budget Values (ABV), i.e. the nett value for each element, stripped of management reserves. The programme should contain one task per Cost Account, Work Package or Planning Package, depending on the level of detail available. The Elements are summarised into a series of Hammocks to produce the overall Master Schedule and are connected to a series of Milestones designed to pick up progress information from all the CA programmes.

Figure 8 shows a suggested project structure

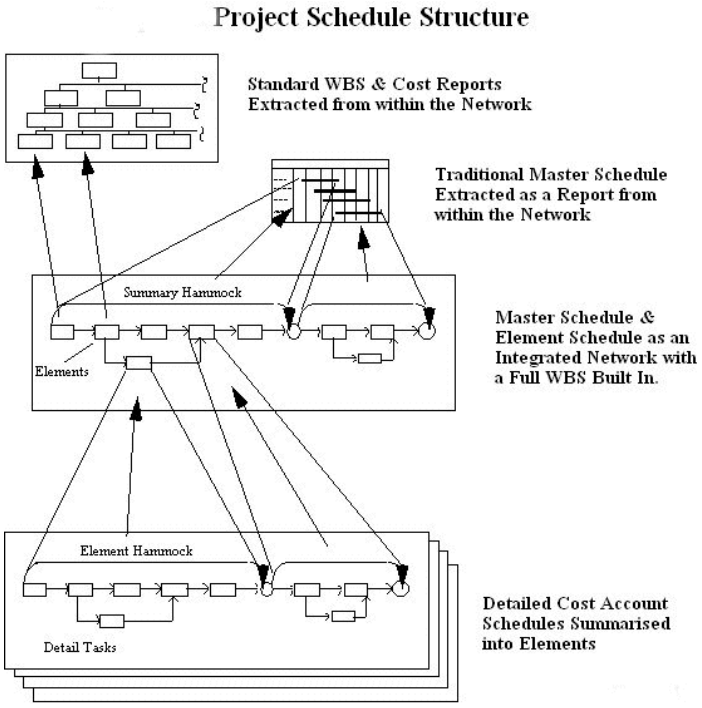


Figure 8. Suggested Project Structure

This programme is the source of most of the Cost and Schedule reporting required from the Contractor. Progress and actual cost data is obtained from the individual CA programmes and should be uploaded electronically, but not automatically. I feel each CAM should be required to certify the accuracy of the data from his or her CA and senior Functional or Departmental management must have the option to require changes and amendments before the data is accepted into the Master Programme. The decision to build the Master Programme (Element Schedule) at the CA or Package level will depend on the available information and the interaction with other CAs. One of the prime functions of the Element Schedule is to map the interactions between the different CAs.

The Cost Account Schedule

These detailed programmes are the driving force of the whole structure. Initially they are developed to meet the requirements of the master programme and once agreed, have their own baseline stored to allow the CAM to manage his section of the works. The programmes should be designed to allow all cost and schedule data to be summarised into blocks identical to the activities in the Elemental Schedule, for transfer to Elements in the Master Programme (Refer Figure 4) for full project update and reporting purposes. Milestones in the CA programme should match Milestones in the Master Programme to allow the two-way transfer of progress information.

The decision between building one detailed schedule per work package or one schedule for the full CA with each Work Package occupying a separate Subproject will largely depend on resource constraints and the size of the CA. If several Work Packages are drawing resources from the same pool, at the same time, or the CA is relatively small, a single schedule is recommended. If the Work Packages are large and relatively independent, separate schedules may be preferable. The decision is largely the responsibility of the CAM provided reporting standards are maintained and the programmes are capable of accurately reporting progress and its effect on Milestones linking to other CAs.

Within the Contractors own organisation, data relating to the expected delivery dates for the various Milestones can be automatically transferred between the various CA programmes, however, the movements in milestones from external subcontractors can probably only be garnered from information provided to the Planning Engineers looking after the Master Programme and downloaded from Master Programme Milestones to the relevant CA Milestones prior to updating the programme.

Departmental Resource Programmes

One noticeable omission from traditional EVPM planning is the Department Level Resource planning. In my experience, this is one of the key constraints on the completion of CA works. A typical Department may have several CAM running their own CAs and they may well be working on completely different projects. The Department Managers role is to allocate his or her scarce resources to the CAs with most important / urgent work to complete. Provided the Department and Company have established overall planning standards, this process is relatively simple but often requires significant data management capabilities. To resource analyse the departments overall requirements and commitments, all the relevant CA programmes are merged into a single Department Programme and analysed against the available resources. The resource levelled scheduled is then passed back to the various CAMs with information regarding the number of resources allocated to the CAM for the next period. The CAM is then free to rearrange his schedule within the overall resource limits imposed by the Department but cannot exceed these limits. The consequences of the Departmental scheduling are of course passed back up to the Master Programme from the CA Programme. At the same time, consolidating the full resource demands against the Department into a single schedule allows detailed resource planning for the department to be undertaken and decisions on staffing levels, recruitment, etc. to be made based on complete information.

A variation on the process described above is to pass the Elemental data directly to the Master Programme from the Departmental analysis. The method chosen will depend on the relative importance of the Project

Team and the Department. In a single project organisation, the path would most probably be: CAM -> Department -> Master Programme. In a multi-project organisation, the path would probably be: Department -> CAM -> Master Programme.

Data Exchange Requirements

The planning strategy outlined above requires the ready transfer of data between various levels of a project and to be successful requires the establishment of a series of Planning Data Standards within an organisation. These standards will be very similar to those required by a Total Quality Management system and should not, therefore, add any workload to the project planning staff. Figure 9 outlines Programme levels and the data movements discussed to date.

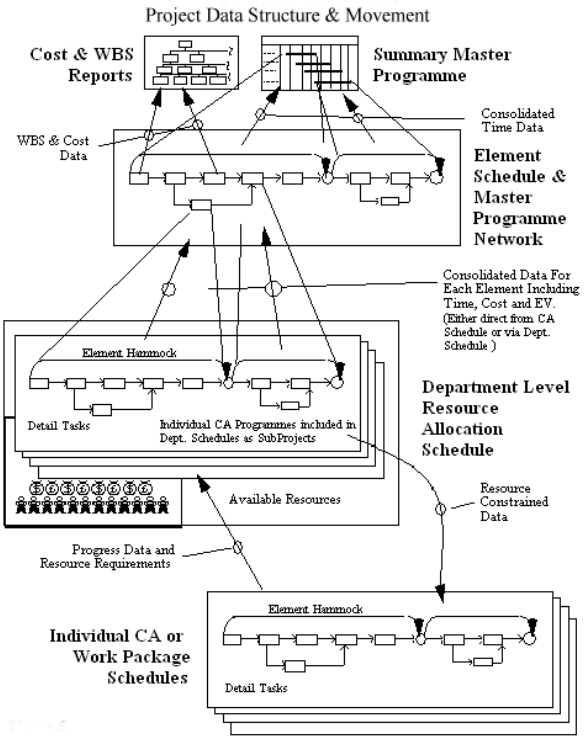


Figure 9. Programme Levels and Data Movement

Some areas of the data need to be identical for the transfers to work, these include: -

- Calendars (including names, structure and holidays / overtime)
- Labels and Code Structures (for reporting)
- WBS Elements within the one project
- OBS Elements within the one project
- Resources (the same resource name needs to mean the same person, team, etc, in all projects.)

- Milestone Identification

Other areas of the data need to be unique to allow the transfers to work, including: -

- Event and Task identifiers always need to be unique
- Resource names (different projects cannot use the same name for different resources)
- WBS Elements between different projects
- OBS Elements between different projects

Other areas may need to be common but can vary depending on the software used to process the information, e.g. If Micro Planner or Open Plan is being used to process the consolidated project data, the "Time Now" or status date for the progress information needs to be identical on all the data being imported.

Data exchange between the Department and CA level is relatively straight forward, the relevant CA programmes are simply absorbed into a larger version of the whole, complete with all the relevant details and then downloaded after analysis. No data conversion takes place unless different types of software are used to overcome capacity problems and then all that is required is appropriate Import / Export systems. Moving data between the CA programmes and the master programme is more complex as summary data from each CA programme must be transformed into detail (or actual) data for import into the Master Programme. This is not particularly difficult using a spreadsheet or database to make the changes on the way across and as suggested above, stopping the data at this point for verification and authorisation can be an advantage. The more difficult problem is the efficient transfer of Milestone data between different CA projects, e.g. to transfer the date the design is finished (from the design CA) to the manufacturing CA. Typically, these may be separate projects on different computers under the control of different CAM.

Progress Control - Time

EVPM assumes a dynamic planning and cost control process. As earlier CAs are completed, the information becomes available to detail the processes required to complete later CAs. The essence of EVPM time management falls into two parts; the first is to attempt to plan the work required for each Work Package to allow a local time buffer (or float) to take account of progress problems within the single CA.

If this is not possible, the Project Manager may authorise the release of some of the Projects time contingency (float) or decide to accept the negative cost variance involved in using additional resources and release appropriate management reserves. Generally, a negative programme variance that impacts on the overall project baseline will not be accepted unless a full project rebaseline is authorised.

Once the CA Programme is agreed and has its baseline locked in, the management cycle set out in Figure 7 comes into play. The results of each status processed being passed on to the Master programme and the Departmental Programme. This process is the same as that used in any project that is being effectively managed and does not require much further comment other than to refer to the linkage between progress on the critical path measured by time-based reporting and the quantity of work being completed that is discussed below.

The Analysis Process

Many if not most of the CA plans will change quite regularly and attempting to understand what the current position is within one CA or over the whole project vis a vis the original plan is quite difficult. Milestone and time-based progress reporting of the Current Status -v- the Original Plan only gives a part of the picture, I previously mentioned that EVPM gives the rest. Re-iterating my previous statements, EVPM is a simple but effective way of understanding how a project is currently performing against the original plan in terms of the value of work completed and is at the heart of the methodology. The original plan (both time and costs) is stored as the BASELINE SCHEDULE containing the original (ABV) cost plan as its BUDGET. As time progresses, tasks are being completed and the budget is being expended in the form of outlays that may or may not be in line with the original intentions and require controlling.

Unfortunately, there are many variations in the way different software packages approach resource and cost management, to avoid confusion; I will discuss the way Micro Planner X-Pert operates which is consistent with EVPM requirements. Micro Planner X-Pert calculates the Baseline costs by defining for each task its' resource requirements and multiplying that requirement by the appropriate rate for the resource against time (cash outlays can be added to an activity as a "Total Cost").

From this information the Resource Analysis segment of the program whilst allocating the resources calculates the cost of each activity against time. The program then can produce a cash flow curve showing how and when the costs will be expended. Once the original plan is agreed, this is stored in the Master Archive to become the Baseline Schedule and Original Budget against which future progress can be measured.

Through the effluxion of time and effort, activities will progress, and expenses will occur. This is reflected within Micro Planner by the process of reporting progress. Time Now is moved forward to show the passage of time and each activity that has incurred progress and actual costs is updated. The program is run once more, and the actual costs and progress are plotted on the cash flow curve against the original expectations.

Figure 2, clearly shows that the actual expenditure on this project is falling behind the planned expenditure. The problem the project manager is faced with is, 'what does this mean'? It could be that in the current economic climate cheaper and more efficient ways of working have been found. If this trend is continued, then the project team will come home on time and under budget! It could be since the program is behind schedule because of inclement weather or strikes etc. This would then trend out showing the project finishing well behind programme. All that the cost curve shows is that the project is not running to schedule in terms of the money expended. Whether the project is better or worse off is not apparent and this comparison gives no useful information regarding the project's real status.

Consider for a moment a project that is in trouble and too much has been spent to achieve the little work that has been Completed. The actual costs (money spent) may appear to be on or close to target but the real situation is very different, more information is required! Cost monitoring on its own cannot provide the answer, cost reporting is normally carried out in a historical way, which in normal accounting circles in some contractors requires 4 to 6 weeks to process. Given this lag of 4 - 6 weeks for accurate cost information, it becomes very difficult for management to know where the project is and without management being able to effectively monitor the situation there cannot be control.

Micro Planner's 'Short Term Progress Bar chart' and / or its 'Progress Report' can help. These reports are designed to compare actual progress against planned work using time and dates as the basis. This may help to pinpoint the areas where the project is slipping and allow corrective action to be taken but if the works on the critical path are largely holding programme, identifying the problem areas in a large network may still not be easy as neither time reporting nor the cash spent to date are a measure of the VALUE of work achieved. Even if the problem has been identified, effective control is still required to carry out the corrective actions.

EVPM is as I have already stated is a methodology that allows the project manager to compare the value of real work done with the value of work that was supposed to be done. The use of BCWS and BCWP as well as ACWP provides a most valuable story of how the project is performing.

It must be remembered that indirect costs should also be considered when using EVPM, with Micro Planer this is a simple matter of including a Hammock activity and placing the various indirect cost types on it. One of the key decisions in setting up a EVPM system is to decide where and how each of these overhead costs are to be accounted, either in the Master Programme or in the CA Programmes.

The key to successful EVPM is deciding on the extent of progress achieved to the status date. Completed activities, and activities that have not yet started are easy to measure, values for partially completed activities are, however, a little more difficult. If part of the steel hull has been welded how much have, we earned?

The Federal Government has for many years in its tenders stated that activities should be specified with durations no longer than 10 working days! Unfortunately, many planners tend to create long duration activities and measuring progress value on these is more complex and less accurate than on short activities. However, EVPM has been designed to cope with this, even though most activities will be measured on completion, it is possible to specify Earned Value on partially completed tasks. As a hangover from the days of manual calculations of the Earned Value, one of three different ratios can be used to bring the EV to account, 0/100, 50/50 or 100/0. 0/100 method says no Earned Value is achieved until the task is complete, 50/50 method says 50% of the value is earned as soon as the task has started, with the balance not being taken to account until the task is complete. 100/0 method allows 100% of the earned value to be taken to account as soon as the task is started.

Another option (a variation on the 0/100 method) is to identify a series of "Payment Milestones", the EV only being available to the Contractor after the Milestone is achieved. The key factor is to be consistent in the method adopted so that the Baseline Budget and Earned Value are calculated in the same way.

From this relatively simple start the complications set in, the full EVPM system requires Contractors to account for Change Orders, Budget and Time Contingencies and adjustments, Trends, Inflation, Accruals, Variance and many other factors. As well as calculating the situation at "Time Now", the consequences of progress to date need to be projected on to the completion of the project. A similar set of ratios and values to the ones at "Time Now" are used including; Budget At Completion (BAC), Recoverable Budget Ceiling, Estimate To Complete (ETC), Estimate At Completion (EAC), and Variance At Completion (VAC). Figure 10 show a project with most of these factors considered, full definitions of the terms used are included in the Glossary attached to this paper.

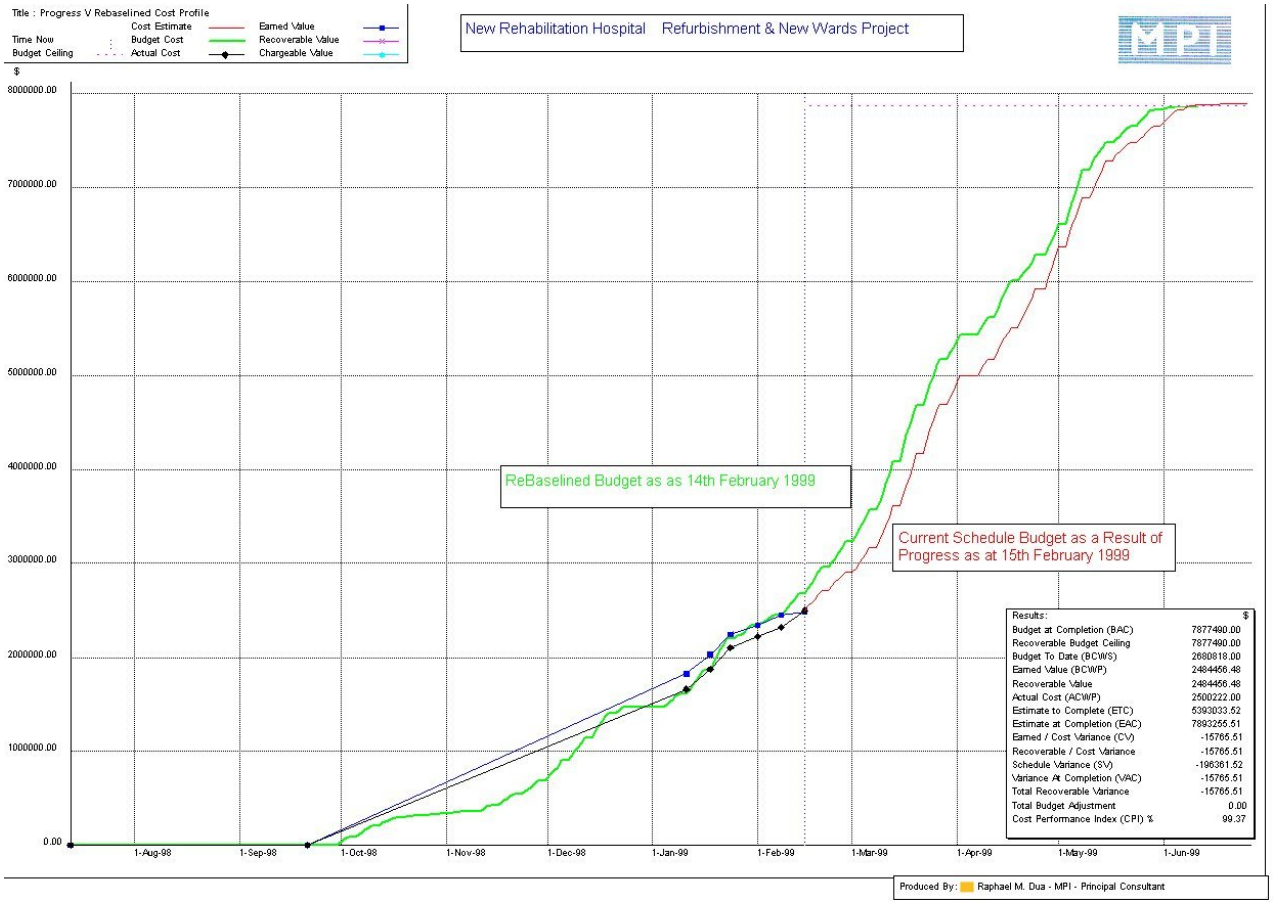


Figure 10: Rebaselined EVPM Curves and Ratios

EVPM Currently

The ongoing success in the wide range of implementation across industry has seen the International standards Organisation to create with the Australian Standards help a new standard for implementing EV, this is being achieved by the release of the new standard by Standards Australia, which is using the MB-12 Committee on Project Management Standards.

To quote from the ISO web page the new standard is known as ISO 21508:2019 as a short description of its contents are shown below

ISO 21508:2018

EARNED VALUE MANAGEMENT IN PROJECT AND PROGRAMME MANAGEMENT

ISO 21508:2018 provides guidance for practices of earned value management in project and programme management. It is applicable to any type of organization including public or private and any size or sector, as well as any type of project or programme in terms of complexity, size or duration.

ISO 21508:2018 provides the following:

a) terms and definitions;

b) descriptions of the purpose and benefits of earned value management;

c) the integration and relationship with project or programme management;

d) an overview of the processes and process descriptions;

e) basic requirements for an earned value management system;

f) use of an earned value management system.

ISO 21508:2018 does not provide guidance on the use of specific processes, methods or tools in the practice of earned value management.

Annexes A, B and C describe cost, schedule and performance analysis, commonly used formulae with associated interpretations, and the integration of earned value with other project or programme management processes.

APPENDIX 2

Earned Value Management Worked Example

The following shows the basics of how EVM works in practice, using a simple one task example:

A software package to run a program logic controller for a new "Inspection Device" (made up of several activities) with a budget of 1000 hours, has been defined and all the activities and estimated the effort (i.e. hours) required for each task. It is expected the work package to take 12 weeks. At the end of week 6, the plan is to have completed 55% of the scope (by effort), i.e. 55% of the total activities within the work package, as the sum of the hours of the activities planned to be completed at the end of week 6 = 550 hours. The 550 hours can also be translated into cost ($) using average cost rates. This is what is referred to as planned value or BCWS (at end of week 6).

At the end of week 6 would find:

- the planned value PV or (BCWS) = 550 hours
- however, on assessing actual progress (using activities completed, known as the 0/100 method) now can calculate that the project has only completed activities worth 350 hours of the total task's budget***
- the actual expenditure of those same completed activities to be 480 hours.

In earned value techniques, this gives a Planned Value of 550 hours, Earned Value (EV) of 350 hours, and Actual Cost (AC) (in hours) of 480.

What can be learned from this?

Basically the project is behind schedule (earned is less than planned) and it is over budget (actual is greater than earned).

Several other things which can also be done such as calculate cost and schedule performance indices: cost performance index (CPI) and schedule performance index (SPI), where a CPI/SPI of 1.0 equals *performance* to plan; less than 1.0 is *performance* less than plan.

In this example, the CPI would be (350/480) 0.73 and SPI would be (350/550) 0.64. Such metrics could be produced across a project, say at work package level.

Note: there are many ways of measuring progress and calculating EV – this is just one example – and a full discussion of this subject can be found in other chapters of this paper (Usually 0/100 is favoured over all other methods to assure maximum objectivity) .

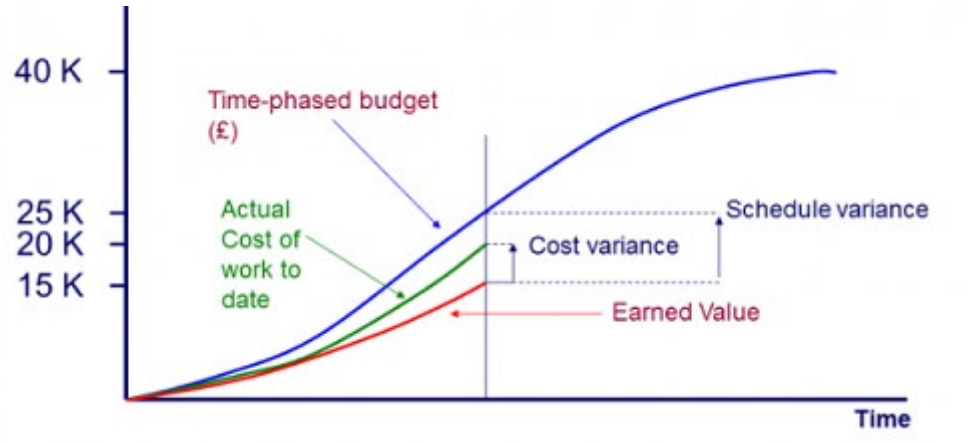
How is this EVM data used?

In the past, it has often been mistakenly believed that EVM data is only produced for financial reasons or for reporting to the client – this is not correct. The most important use of this data is by all those who are responsible for managing work in the project team (using EVM data via the work breakdown structure) to understand their cost and schedule performance, throughout the project lifecycle. The objective is to highlight cost and schedule issues early, thus providing the maximum time to minimise their impact and provide a realistic opportunity to develop recovery plans where necessary.

The next most important thing to be done is to use the data to provide a method of forecasting out-turn on projects – the most commonly used being:

- Estimate of costs at completion (for the total task: EAC), which for the above example = total budget: 1000 / CPI (.73) = 1,371 hours!!
- Estimate of forecast total duration for the task = current plan: 12 weeks / SPI (.64) = just under 19 weeks (although this is a very rough estimate that should be reviewed against project schedules for work remaining)
-

Figure 1 -Cost and Schedule Variance



Unfortunately, there are those within the IT industry who dismiss the above, as both KMPG and Boston group have illustrated in their industry reports on the success and failure of thousands of IT projects; the past is plagued with projects that displayed (performance) characteristics like the above – very few came in on budget or on schedule

REVIEW of Basic EVM Formulas

To understand more clearly how the EV value is to be managed, several terms are defined in EVM *(explained with the example of building 10 houses each has a value of US$1000 expected to be completed in 10 weeks in proportion)*:

- **Planned Value (PV)** — The **budgeted value** of the work completed so far at a specific date
  example: *at end of week 4, altogether 4 houses should be completed, the PV is US$4000*
- **Earned Value (EV)** — The **actual value** of the work completed so far at a specific date (refer to the "Notes on Earned Value Measurement" section below)
  example: *by end of week 4, only 3 houses are completed, the EV is US$3000*
- **Actual Cost (AC)** — The total expenditure for the work so far at a specific date
  example: *by end of week 4, US$4000 was spend, the AC is US$4000*

EVM is based on monitoring these three aspects along the project to reveal the health of the project with the following indices:

- **Schedule Variance (SV)** — difference between PV and EV, to tell whether the project work is ahead of / on / behind **schedule**
  - **SV = EV – PV**
    If the project is behind schedule the SV will be negative (i.e. achieved less than what planned)

If the project is on schedule the SV = 0
If the project is ahead of schedule the SV will be positive (i.e. achieved more than what planned)
- ***example:*** *by end of week 4, the SV = EV – PV = US$3000 – US$4000 = -US$1000 (behind schedule)*

- **Schedule Performance Index (SPI)** — ratio between EV and PV, to reflect whether the project work is ahead of / on / behind **schedule in relative terms**
  - **SPI = EV/PV**
    If the project is behind schedule the SPI < 1 (i.e. achieved less than what planned)
    If the project is on schedule the SPI = 1
    If the project is ahead of schedule the SPI > 1 (i.e. achieved more than what planned)
  - ***example:*** *by end of week 4, the SPI = EV/PV = US$3000/US$4000 = 0.75 (behind schedule)*
- **Cost Variance (CV)** — difference between PV and AC, to tell whether the project work is under / on / over **budget**
  - **CV = EV – AC**
    If the project is over budget the CV will be negative (i.e. achieved less than spent)
    If the project is on budget the CV = 0
    If the project is under budget the CV will be positive (i.e. achieved more than spent)
  - ***example:*** *by end of week 4, the CV = EV – AC = US$3000 – US$4000 = -US$1000 (over budget)*
- **Cost Performance Index (CPI)** — ratio between EV and AC, to reflect whether the project work is under / on / over **budget in relative terms**
  - **CPI = EV/AC**
    If the project is over budget the CPI < 1 (i.e. achieved less than spent)
    If the project is on budget the CPI = 1
    If the project is under budget the CPI > 1 (i.e. achieved more than spent)
  - ***example:*** *by end of week 4, the CPI = EV/AC = US$3000/US$4000 = 0.75 (over budget)*

Note both SV and SPI / CV and CPI give similar information on schedule / budget, but the indices will give more insights into the actual performance with a meaning comparison.

Conclusion

EVPM is now an essential project management tool for the IT industry as well as other major industries, not only just for the Department of Defence and its projects and thus cannot be ignored in the general Project Management community. Already many non-defence projects, have however, benefited from using some of the EVPM methods, particularly Earned Value Analysis without submitting to the full rigors of certification.

The basic philosophies of breaking a project into manageable chunks, setting cost, quality and performance targets for managers and monitoring progress at the Cost Account level are all effective techniques.

ACKNOWLEDGEMENTS AND MATERIAL USED DURING RESEARCH FOR THIS COURSE

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17 Sarbanes-Oxley Act June 2002
18 Corporate Law Economic Reform Program 9

SOME LIGHT READING :- A SHORT BIBLIOGRAPHY OF USEFUL EVPM LITERATURE

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Notes :-

1) For access to the US DoD and 'Mil' References, write to or contact

The Superintendent of Documents,

U.S. Government Printing Office,

Washington, D.C.,

U.S.A. 20402.

2) For access to the ISO 21508 go to the following URL,

https://www.iso.org/standard/63582.html

3) The author recognises all registered trade and business names referred to in this paper.